A7: AUTOMATA AND COMPUTABILITY

"Ambiguity is something that I really respond to. I like the complexity of it." — Robert Redford

Course: CS 5006
Summer 2018
Due: 29 June 2018, 5pm

OBJECTIVES

After you complete this assignment, you will be comfortable with:

- Deterministic Finite Automata
- Regular Expressions
- Regular Languages
- Turing Machine computation

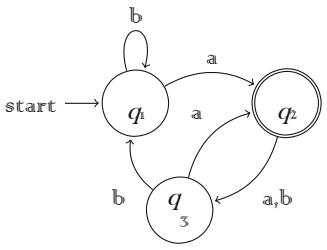
RELEVANT READING

- Online reading
- Lecture notes

EXERCISES

Problem 1: 1 (4 points)

For the finite automaton (DFA) below, answer the questions.



(a) (1 point) What's the start state? q1

(b) (1 point) What's the set of accept states? q2

(c) (1 point) What sequence of states do the machine go through on input aabb. q1, q2, q3, q1, q1

(d) (1 point) Does the machine accept aabb? no

Problem 2: 2 (7 points)

Give the formal description of the machine M_1 in the previous problem.

$Q = \{q1, q2, q3\}$

$\sum = \{a, b\}$

States	a	b
q1	q2	q1
q2	q3	q3
q3	q2	q1

q1 is the state state.

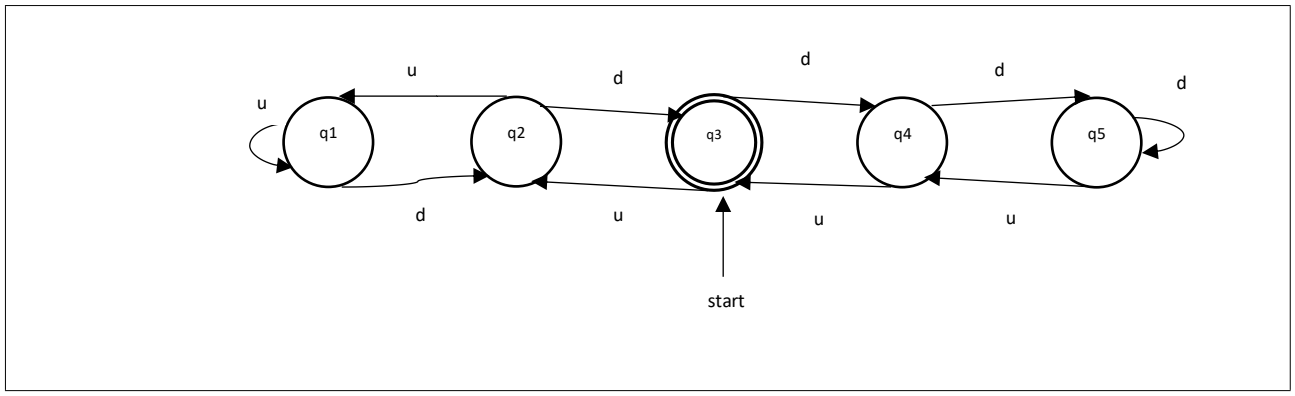
$F = \{q2\}$ is the accept state.

Problem 3: 3 (5

The formal description of DFA M is $\{q_1, q_2, q_3, q_4, q_5\}$, $\{u, d\}$, δ, q_3, $\{q_3\}$, where δ is specified below:

	u	d
q_1	q_1	q_2
q_2	q_1	q_3
q_3	q_2	q_4
q_4	q_3	q_5
q_5	q_4	q_5

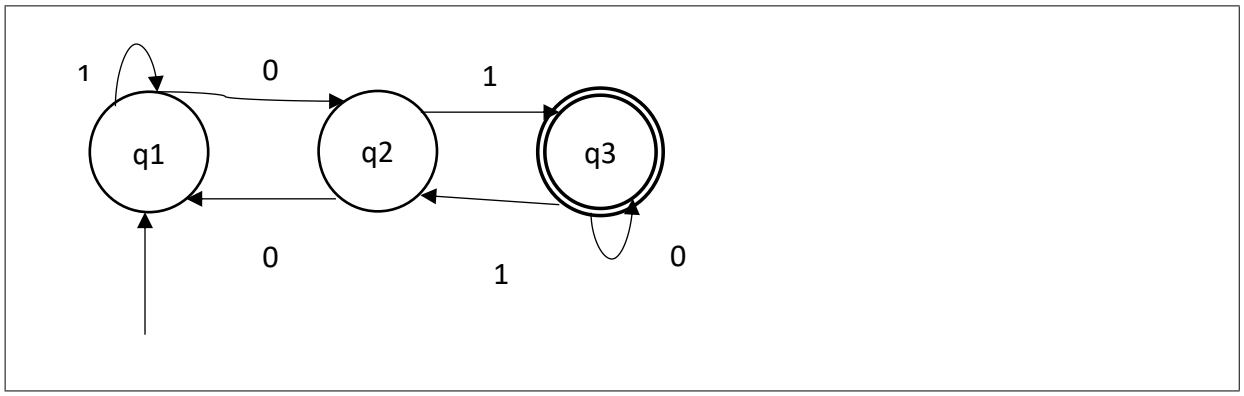
Draw the state diagram for M.



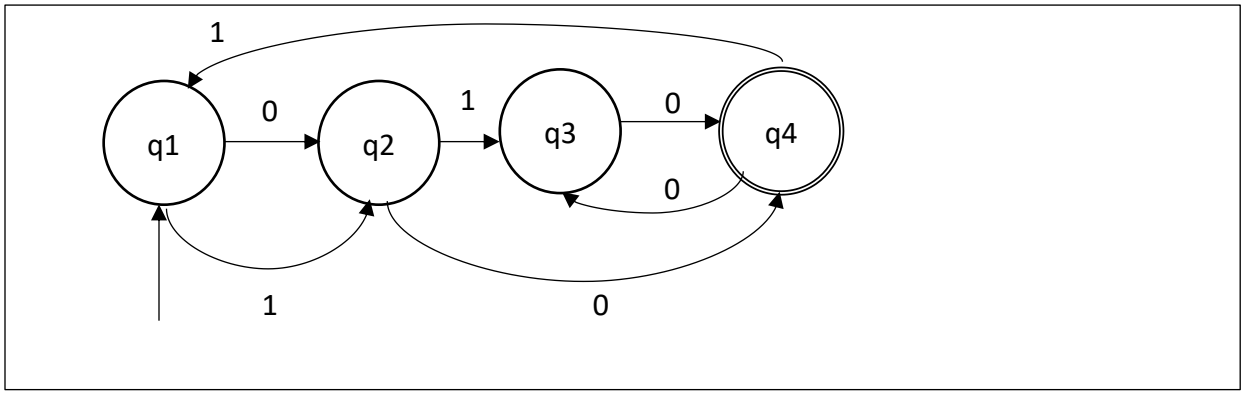
Problem 4: 4 (6 points)

Give the state diagram of the DFA recognizing the following

languages. (a) (3 points) $\{w/w$ begins with a 1 and ends with a 0$\}$



(b) (3 points) $\{w/w$ has length at least 3 and third symbol is a 0$\}$



Problem 5: 5 (4

Recall that a regular expression is defined thus: R is a regular expression if R is:

- a for some a in the alphabet Σ
- E (language containing a single empty string)
- $\emptyset$ (language that contains no strings)
- $(R_1 \cup R_2)$ where R_1 and R_2 are regular expressions
  - $(R_1 \cup R_2) = \{x / x \in R_1 \text{ or } x \in R_2\}$
  - Union
- $(R_1 \circ R_2)$ where R_1 and R_2 are regular expressions
- Concatenation
  - $(R_1 \circ R_2) = \{xy / x \in R_1 \text{ and } y \in R_2\}$
- (R_1^*) where R_1 is a regular expression
  - $(R_1^*) = \{x_1, x_2, \ldots x_k / k \geq 0 \text{ and each } x_i \in R_1\}$

An example:

$0^*10^* = \{w / w \text{ has exactly a single } 1\}$

$\Sigma^*1\Sigma^* = \{w / w \text{ has at least one } 1\}$

Give a regular expression generating the language below. The alphabet is $\Sigma = \{0, 1\}$

(a) (2 points) $\{w / w$ begins with a 1 and ends with a $0\}$

1Σ*0

(b) (2 points) $\{w / w$ has length at least 3 and third symbol is a $0\}$

010*

Problem 6: 6 (6 points)

For each of the following languages, give two strings that are members, and two strings that are not members—4 strings for each part. Assume the alphabet $\Sigma = \{a, b\}$ in all parts.

(a) (2 points) $a*b*$

aabb - member
aaaabbb - member
baabaa – not member
aaaaaa – not member

(b) (2 points) $a(ba)*b$

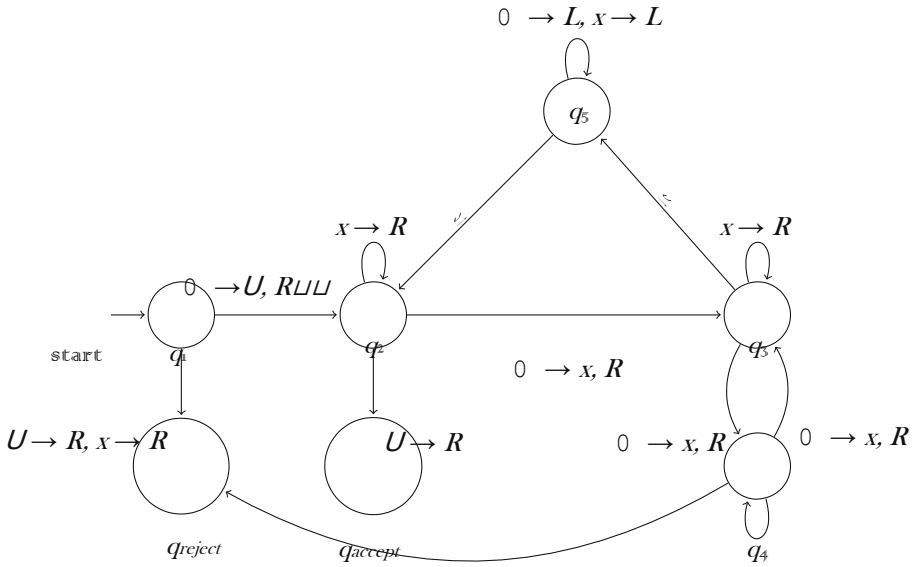
abababababab - member
ababab - member
aa – not member
ab – not member

(c) (2 points) $(aaa)*$

aaaaaaaaa - member
aaa - member
ababb – not member
aabb – not member

Problem 7: 7 (5 points)

For the Turing Machine provided below, give the sequence of configurations that M_2 enters when started on the input string "oo".



$x \rightarrow R$

$U \rightarrow R$

When we see $0 \rightarrow U, R$ on the

edge between q_1 and q_2, that means when in state q_1 and the head reads o, the machine goes to state $q2$, writes U, and moves head to the right. That is, $\delta(q_1, 0) = (q_2, U, R)$.

$\delta(q1, 0) = (q2, \sqcup, R)$

$\delta(q2, 0) = (q3, x, R)$

SUBMISSION DETAILS

Things to submit:

- Submit your assignment in your Github repo.
  - The written parts of this assignment as a .pdf named "CS5006_[lastname]_A7.pdf". For example, my file would be named "CS5006_Slaughter_A6.pdf". (There should be no brackets around your name).
  - Make sure your name is in the document as well (e.g., written on the top of the first page).
  - Make sure your assignment is in the A5 folder in your Github repo.

HELPFUL HINTS

- Ask clarification questions on Piazza.
- Remember, your write-up should convince graders and instructors that you are providing your own work and should showcase your understanding.
- Use the resources page on the course website for supplemental materials.
- In general, problems will be graded both on whether you are taking the right approach and whether you got the right answer. So, show your work and explain your thinking.